

**UTILITY PATENT APPLICATION TRANSMITTAL  
(Small Entity)***(Only for new nonprovisional applications under 37 CFR 1.53(b))*Docket No.  
A-7052Total Pages in this Submission  
69**TO THE ASSISTANT COMMISSIONER FOR PATENTS****Box Patent Application  
Washington, D.C. 20231**

Transmitted herewith for filing under 35 U.S.C. 111(a) and 37 C.F.R. 1.53(b) is a new utility patent application for an invention entitled:

**Ceramic/Metal Substrate, Especially Composite Substrate**

and invented by:

**Jurgen Schulz-Harder**If a **CONTINUATION APPLICATION**, check appropriate box and supply the requisite information:☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: \_\_\_\_\_

Which is a:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: \_\_\_\_\_

Which is a:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: \_\_\_\_\_

Enclosed are:

**Application Elements**

1. ☐ Filing fee as calculated and transmitted as described below
2. ☒ Specification having 21 pages and including the following:
  - a. ☒ Descriptive Title of the Invention
  - b. ☐ Cross References to Related Applications *(if applicable)*
  - c. ☐ Statement Regarding Federally-sponsored Research/Development *(if applicable)*
  - d. ☐ Reference to Microfiche Appendix *(if applicable)*
  - e. ☒ Background of the Invention
  - f. ☒ Brief Summary of the Invention
  - g. ☒ Brief Description of the Drawings *(if drawings filed)*
  - h. ☒ Detailed Description
  - i. ☒ Claim(s) as Classified Below
  - j. ☒ Abstract of the Disclosure

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69

**Application Elements (Continued)**

3. ☒ Drawing(s) *(when necessary as prescribed by 35 USC 113)*  
a. ☒ Formal      b. ☐ Informal      Number of Sheets 8
4. ☒ Oath or Declaration  
a. ☐ Newly executed *(original or copy)*      ☒ Unexecuted  
b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional application only)*  
c. ☒ With Power of Attorney      ☐ Without Power of Attorney  
d. ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application,  
see 37 C.F.R. 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation By Reference *(usable if Box 4b is checked)*  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Computer Program in Microfiche
7. ☐ Genetic Sequence Submission *(if applicable, all must be included)*  
a. ☐ Paper Copy  
b. ☐ Computer Readable Copy  
c. ☐ Statement Verifying Identical Paper and Computer Readable Copy

**Accompanying Application Parts**

8. ☐ Assignment Papers *(cover sheet & documents)*
9. ☐ 37 CFR 3.73(b) Statement *(when there is an assignee)*
10. ☒ English Translation Document *(if applicable)*
11. ☐ Information Disclosure Statement/PTO-1449      ☐ Copies of IDS Citations
12. ☒ Preliminary Amendment
13. ☒ Acknowledgment postcard
14. ☐ Certificate of Mailing  
☐ First Class      ☐ Express Mail *(Specify Label No.):* \_\_\_\_\_

**UTILITY PATENT APPLICATION TRANSMITTAL  
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**Accompanying Application Parts (Continued)**

15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)

16. ☒ Small Entity Statement(s) - Specify Number of Statements Submitted: 1 (unexecuted)

17. ☒ Additional Enclosures (please identify below):

"Marked-Up Specification" and "Substitute Specification"

**Fee Calculation and Transmittal**

**CLAIMS AS FILED**

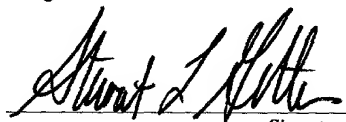
For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	26	- 20 =	6	x \$9.00	\$54.00
Indep. Claims	1	- 3 =	0	x \$39.00	\$0.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$345.00
OTHER FEE (specify purpose)					\$0.00
TOTAL FILING FEE					\$399.00

☐ A check in the amount of \_\_\_\_\_ to cover the filing fee is enclosed.

☐ The Commissioner is hereby authorized to charge and credit Deposit Account No. \_\_\_\_\_ as described below. A duplicate copy of this sheet is enclosed.

- ☐ Charge the amount of \_\_\_\_\_ as filing fee.
- ☐ Credit any overpayment.
- ☐ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: \_\_\_\_\_



Signature

Stewart L. Gitler - Reg. 31,256  
Hoffman, Wasson & Gitler, P.C.  
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**20741**

CC:

PATENT TRADEMARK OFFICE

<b>VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR</b>			Docket No. <b>A-7052</b>
Serial No.	Filing Date	Patent No.	Issue Date
Applicant/ <b>Jurgen Schulz-Harder</b> Patentee:			
Invention: <b>CERAMIC/METAL SUBSTRATE, ESPECIALLY COMPOSITE SUBSTRATE</b>			
<p>As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:</p> <p> <input type="checkbox"/> the specification to be filed herewith.  <input checked="" type="checkbox"/> the application identified above.  <input type="checkbox"/> the patent identified above.         </p> <p>I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).</p> <p>Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:</p> <p> <input checked="" type="checkbox"/> No such person, concern or organization exists.  <input type="checkbox"/> Each such person, concern or organization is listed below.         </p> <p><b>*NOTE:</b> Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)</p> <div style="margin-top: 10px;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">FULL NAME</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">ADDRESS</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div><input type="checkbox"/> Individual</div> <div><input type="checkbox"/> Small Business Concern</div> <div><input type="checkbox"/> Nonprofit Organization</div> </div> </div> <div style="margin-top: 10px;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">FULL NAME</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">ADDRESS</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div><input type="checkbox"/> Individual</div> <div><input type="checkbox"/> Small Business Concern</div> <div><input type="checkbox"/> Nonprofit Organization</div> </div> </div> <div style="margin-top: 10px;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">FULL NAME</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">ADDRESS</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div><input type="checkbox"/> Individual</div> <div><input type="checkbox"/> Small Business Concern</div> <div><input type="checkbox"/> Nonprofit Organization</div> </div> </div> <div style="margin-top: 10px;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">FULL NAME</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">ADDRESS</div> <div style="width: 85%; border-bottom: 1px solid black;"></div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div><input type="checkbox"/> Individual</div> <div><input type="checkbox"/> Small Business Concern</div> <div><input type="checkbox"/> Nonprofit Organization</div> </div> </div>			

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Jurgen Schulz-Harder

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

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NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the applition of:

**Jurgen Schulz-Harder**

Group Art Unit:

Serial No : **Not yet awarded**

Examiner:

Filed :

For : **CERAMIC/METAL SUBSTRATE,  
ESPECIALLY COMPOSITE SUBSTRATE**

**PRELIMINARY AMENDMENT**

Commissioner of Patents and Trademarks  
Washington, D.C. 20231

Sir:

Please amend the above-identified application as follows:

**In the Specification:**

Please delete the current Specification and replace same with the "Substitute Specification" attached hereto.

**In the Claims:**

Please cancel claims 1-26 in the original application, and kindly replace same with the following claims:

--27. A ceramic/metal substrate, comprising a ceramic layer having at least two substrate areas connected to each other as one piece and having at least one metal surface on at least one surface side of the ceramic layer and joining each other on at least one predetermined break line provided for in the ceramic layer, wherein the at least one metal surface of each substrate areas has at least one edge reduction on one edge adjacent to the predetermined break line and running along this predetermined break line and that the edge reduction is of a form that the mass of metal there per volume unit (specific metal mass) is reduced 10 to 80 %, with reference to the specific metal mass of a metal surface outside of the edge reduction.

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29. The ceramic/metal substrate according to claim 28, wherein the at least one textured or structured metalization is produced by applying a metal layer or metal foil by a heating process, selected from the group consisting of direct copper bonding and an active soldering.

31. The ceramic/metal substrate according to claim 27, wherein the width (a) of the edge reduction or of the reduced metal mass area is approximately 0.2 to 6 mm.

32. The ceramic/metal substrate according to claim 27, wherein at least one outer metal surface that is provided for on at least one surface of the ceramic layer at least along one edge of the ceramic/metal substrate, and by at least one predetermined break line between the at least one outer metal surface and adjacent substrate areas, whereby the at least one outer metal surface has an edge reduction along the predetermined break line.

33. The ceramic/metal substrate according to claim 27, wherein an edge having the edge reduction has a distance (d1, d2) from the adjacent predetermined break line or a plane (SE) of the predetermined break line that is considerably less than 1 mm.

34. The ceramic/metal substrate according to claim 27, wherein edges with the edge reduction have a distance from the respective predetermined break line of approximately 0.05 to 1 mm.

35. The ceramic/metal substrate according to claim 28, wherein the textured or structured metalizations, or metal surfaces formed by these, have a thickness of between approximately 0.15 to 1 mm.

36. The ceramic/metal substrate according to claim 27, wherein the edge reduction is formed by beveling of the respective edge, the beveling forms an angle smaller than  $45^\circ$  with a plane of the ceramic layer.

37. The ceramic/metal substrate according to claim 27, wherein the edge reduction is formed by hollows or depressions in a material of the metal surface.

38. The ceramic/metal substrate according to claim 37, wherein the hollows or depressions are formed continuously, and extend to a surface side of the ceramic layer adjacent to the metal surface.

39. The ceramic/metal substrate according to claim 37, wherein the hollows or depressions are formed in such a way that metal from the metal surface remains on the surface side of the ceramic layer adjacent to the metal surface.

40. The ceramic/metal substrate according to claim 27, wherein the edge reduction is formed by a number of hole-like depressions that are arranged as a row of holes.

41. The ceramic/metal substrate according to claim 40, wherein outer and inner depressions form an outer and a second inner row of holes.

42. The ceramic/metal substrate according to claim 40, wherein the depressions have a diameter of approximately 0.5 to 0.6 mm.

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Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The *Agrobacterium* strains were grown in YEA medium at 28°C for 24 h. The cell concentration of the strains was adjusted to 10<sup>8</sup> cells/ml. The strains were then mixed with the plant cells and cocultured for 48 h. The transformation efficiency was determined by the number of transformants per 10<sup>5</sup> cells. The data are the mean ± SD of three independent experiments.

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arranged in several rows, two groups of crossing predetermined break lines are formed.

49. The ceramic/metal substrate according to claim 27, wherein on at least one surface area of the ceramic/metal substrate, all edges of the metal surfaces adjacent to a predetermined break line are provided with edge reduction.

50. The ceramic/metal substrate according to claim 27, wherein the metal surfaces on at least one surface area of the ceramic layer has no edge reduction on edges that are adjacent to a group of predetermined break lines.

51. The ceramic/metal substrate according to claim 27, wherein the single substrates formed by substrate areas are not provided with components.

52. The ceramic/metal substrate according to claim 27, wherein the single substrates formed by substrate areas are provided with electric components.--

#### REMARKS

Applicant has amended the claims to coincide with U.S. Patent Practice inserting necessary section headings and the like. A certified copy of the priority document, German Application No. 199 27 046.5 dated June 14, 1999 will be forwarded at a later date. An English translation of the German application is enclosed along with a marked-up copy of the Specification and a clean "Substitute Specification". Further, applicant has cancelled claims 1-26 and inserted replacement claims 27-52 to more accurately comply with U.S. examination procedures. Multiple dependencies have been removed from the claims. By both amendment of the specification and claims, no new matter has been inserted into the application.

Respectfully submitted,

Stewart L. Gitler  
Reg. No. 31,256



June 8, 2000  
(703) 415-0100

Attorney Docket No: A-7052.PAM/cat

**CERAMIC/METAL SUBSTRATE, ESPECIALLY COMPOSITE SUBSTRATE**

**BACKGROUND OF THE INVENTION**

The invention pertains to a ceramic/metal substrate.

5 Ceramic/metal substrates are known, especially ceramic/copper substrates. These substrates are used for the manufacture of electric or electronic circuits, especially electric or electronic power circuits, and form the "printed boards" for these.

10 In the simplest case, such substrates have a ceramic layer that is provided with metalization on both surfaces, of which for example the metalization on the top of the ceramic layer is textured or structured in such a way, for example by using an etching process. The metalization then forms the conductors, contact surfaces etc. required for the switching circuit.

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20  
25 For the efficient production of electric or electronic circuits, a composite or multiple substrate (DE-PS 43 19 944) is known, in which at least two single substrates that are connected to each other as one piece are integrally formed on a large-format ceramic plate or layer. They are provided with at least one metal surface on at least one surface of the ceramic layer and connect by means of at least one predetermined break line in the ceramic layer. The separation of the composite substrate  
30 into the single substrates takes place on these predetermined break lines after applying of the electric or electronic components, by means of breaking. The disadvantage of this is that - due to internal tensions in the ceramic/metal substrate that result from the temperatures arising when applying the metalization and due to the different thermal expansion  
35 coefficients of ceramic and metal - uncontrolled fractures, separation or breakage can occur. Although such uncontrolled breaks occur in only 1 to 5% of all cases, the resulting loss of production and damage is not inconsiderable, especially when the separation into the single substrates does not take place until after assembly.

The application of the metalization takes place in a heat process, i.e., in a process using considerable temperatures. Thus it is known, for example, that the metalization required for electric conductors, connections etc. on ceramic, e.g. on aluminum-oxide ceramic is produced by means of the so-called "DCB process" (direct copper bond technology), using metal or copper foils or metal or copper sheets forming the metalization that have a layer or a coating (melt-on layer) consisting of a chemical compound of the metal and a reactive gas, preferably oxygen. In this process, which is described for example in US-PS 37 44 120 or DE-PS 23 19 854, this layer or coating (melt-on layer) forms an eutectic system with a melting temperature under the melting temperature of the metal (e.g. copper), so that by application of the foil on the ceramic and by heating all layers these can be connected to each other, by melting on the metal or copper in the area of the melt-on layer or oxide layer.

This DCB technology then has the following processing stages:

- Oxidation of a copper foil in such a manner that an even copper oxide layer is formed;
- Application of the copper foil to the ceramic layer;
- Heating of the compound to a processing temperature between approximately 1065 and 1083°C, e.g. to approx. 1071°C;
- Cooling to room temperature.

The object of the invention is to avoid this disadvantage.

#### SUMMARY OF THE INVENTION

Surprisingly, random or controlled breaks can be reduced considerably (proven up to 75%) when separating the ceramic/metal substrate with the embodiment according to the present invention.

**BRIEF DESCRIPTION OF THE FIGURES**

The invention is described in more detail using example embodiments in the following figures, wherein:

FIG. 1 shows a simplified representation in top view of a ceramic/metal substrate in the form of a composite substrate according to the present invention in unassembled condition;

FIG. 2 shows a simplified representation in bottom view of the composite substrate in FIG. 1;

FIG. 3 shows a section corresponding to the line I-I in Figure 1;

FIG. 4 shows an enlarged partial representation of the rear view of the composition substrate in FIG. 1;

FIG. 5 shows a partial section through the composite substrate in a possible embodiment;

FIG. 6 shows an enlarged partial representation of a view of the bottom of the composite substrate in FIG. 1 in the area of a single substrate in a further possible embodiment;

FIG. 7 shows a partial section corresponding to the line II-II in Figure 6;

FIGS. 8, 9 and 10 each show an enlarged partial representation of a view of the bottom of the composite substrate in a further embodiment;

FIG. 11 shows a section corresponding to the line III-III in Figure 10;

FIG. 12 shows a representation similar to Figure 6 of a further possible embodiment;

FIG. 13 shows a section corresponding to the line IV-IV of Figure 12;

FIG. 14 shows a simplified representation of a bottom view of a composite substrate of a further embodiment of the invention;

FIG. 15 shows a section through the composite substrate of Figure 14 corresponding to the line V-V of Figure 14;

FIG. 16 shows a top view of an assembled composite substrate; and

FIG. 17 shows a further possible embodiment in a representation similar to FIG. 2.

#### **DETAILED DESCRIPTION OF THE INVENTION**

For the sake of simplicity, three perpendicular spatial axes (X-axis, Y-axis and Z-axis) are indicated in the Figures 1-13, of which the X- and Y-axes define the plane of the respective composite substrate (X-Y plane) and the Z-axis lies in the direction of the thickness of the respective composite substrate.

The composite substrate depicted in Figures 1- 4 and generally referred to as 1 consists essentially of a ceramic plate or ceramic layer 2 that is, for example, aluminum nitride ceramic, or aluminum oxide ceramic, and in the embodiments of Figures 1 - 3 is provided with a textured metalization on both surfaces, on the top with the metalization 3 and on the bottom with the metalization 4. The metalizations are achieved in the depicted embodiments by applying a metal foil, e.g. a copper foil to each surface of the ceramic layer 2 by means of the DCB

technology. The texture or structuring of the metalizations 3 and 4 is effected with the usual means known to the trade, for example, by means of masking and etching processes.

For the composite substrate 1, the metalization 3 on the top is textured in such a way that it forms several metal surfaces 3' that are provided for in several rows extending the direction of the X-axis and connecting with each other in the direction of the Y-axis.

The composite substrate 1, in the depicted embodiments, is formed with a rectangular circumference, in such a way that the shorter sides extend in the direction of the X-axis and the longer sides extend in the direction of the Y-axis.

Furthermore, the metalization 3 is textured in such a way that it forms on the edges 5 and 6 rectangular or striated metal surfaces 3'' (along the edges 5) and 3''' (along the edges 6), whereby the two metal surfaces 3'' both extend along the entire width (distance of the two edges 6) of the composite substrate 1 and the two metal surfaces 3'' end with both ends in the vicinity of a metal surface (3'), respectively.

The metal surfaces 3' lie with their edges parallel to the edges 5 and 6 and thus also in the X-axis or Y-axis. Also the striated or elongated rectangular metal surfaces 3'' and 3''' lie with their edges parallel to the edges 5 and 6 and thus in the direction of the X-axis or Y-axis.

All metal surfaces 3', 3'', 3''' are at a distance from an adjacent metal surface, respectively, as described in more detail below. In the free areas of the ceramic layer 2 between the metal surfaces 3', 3'' and 3''', grooves forming predetermined break lines 7 and 8 are effected in such a way that these predetermined break lines extend not only between the individual metal surfaces 3' forming the single substrates, but also between the metal surfaces 3'' and adjacent metal surfaces 3' and 3''' as well as between the metal surfaces 3''' and adjacent metal surfaces 3'. In particular, the predetermined break line 7 extends in the direction of the X-axis and the



predetermined break line 8 in the direction of the Y-axis, whereby an outer predetermined break line 7 that is adjacent to the metal surface 3'' extends across the entire width of the composite substrate 1 in the depicted embodiment, i.e. also in the free areas of the top surface of the ceramic layer 2 between the metalizations 3'' and 3'''. The two outer predetermined break lines 8 both extend between the respective metal surface 3''' and the adjacent metal surfaces 3' and end in the depicted embodiment at the metal surfaces 3'' or at the outer predetermined break lines 7 extending parallel to these metal surfaces.

The metalization 4 on the bottom side of the composite substrate 1 is textured in such a way that this metalization forms a number of metal surfaces 4' that correspond to the metal surfaces 3' and of which one metal surface 4' is directly adjacent to a metal surface 3', respectively. Also the metal surfaces 4' are, in the same manner as the metal surfaces 3', arranged in several rows and lie with their edges parallel to the edges 5 and 6. Furthermore, the metalization 4 forms metal surfaces 4'' and 4''' that correspond to the metal surfaces 3'' and 3''' and of which each metal surface 4'' and 4''' lies adjacent to a metal surface 3'' and 3''', respectively. The metal surfaces 4', 4'' and 4''' are at a distance from each other at the predetermined break lines 7 and 8, so that the bottom of the ceramic layer 2 there is free.

Along the predetermined break lines 7 and 8 the composite substrate, especially after texturing of the metal surfaces 3' and after assembly, can be separated into single substrates or into electric components formed by said substrates by breaking along the predetermined break lines 7 and 8, whereby an opening of the composite substrate 1 is first necessary, wherein the edges provided with the metal surfaces 3'' and 3''' and 4'' and 4''' are broken off, along the outer predetermined break lines 7 or 8. This opening is possible only in a certain sequence, wherein first the outer edges possessing the metal surfaces 3'' and 4'' and then the outer edges possessing the

metal surfaces 3''' and 4''' are broken off. By means of the metal surfaces 3'', 4'' and 3''', 4''', which bridge especially the predetermined break line 7 and 8 extending between the metal surfaces 3', unintentional breakage of the composite substrate 1 is effectively prevented.

Figure 3 shows a partial cross-section through the composite substrate of Figure 1. SE in this figure designates the planes extending perpendicular to the XY plane that enclose the predetermined break lines 7 or 8. As depicted in Figure 3, all metal surfaces 4' of these middle planes SE have a distance d1. The edges of all metal surfaces 3', 3'' and 3''' have a distance of d2 from the adjacent plane SE extending parallel to the respective edge. This applies both for the planes SE that are parallel to the XZ plane and parallel to the YZ plane.

In the depicted embodiment the thickness of the metalization 3 and 4 is, for example, 0.15 - 1.0 mm. Moreover, for the composite substrate 1, the respective distance d2 is greater or equal to d1, whereby d1, for example, is on the order of 1.0 to 0.05 mm. For the composite substrate 1 the distances d2 are greater than 1mm.

The predetermined break lines 7 and 8 are produced, for example, by laser processing, e.g. by laser etching. The predetermined break lines 7 and 8 can, however, also be produced by some other means, e.g. by means of mechanical processing.

Due to the high processing temperatures and the differing heat expansion coefficients of the ceramic material and of the metal of the metalizations during the application of the metalizations 3 and 4 to the ceramic layer 2, mechanical tensions occur in the substrate that are then partially resolved during the texturing of the metalizations 3 and 4 or during the texturing of the metal surfaces 3', whereby residual mechanical tensions remain in the composite substrate, the orientation and size of which cannot be controlled.

In separating the composite or multiple substrate into single substrates by breaking along the predetermined break lines

7 and 8, it can therefore occur that in unfavorable cases a partial residual tension in the composite substrate is added to the forces or tensions arising during breaking in such a way that the breakage does not take place in the desired manner along the respective predetermined break line 7 or 8, but along a deviating random break line, indicated in Figure 4 by the broken line 9.

Especially when the separation of the composite substrate does not take place until after the addition of components, such uncontrolled breaks 9 can cause considerable damage, since the respective single substrates are then no longer usable. The damage in this case is not limited to the costs of the single substrate, but also includes the labor and machine costs for assembly and the costs of the components that have been assembled on such a defective single substrate. As a rule of thumb, the value of an assembled single substrate is approximately 10 times that of an unassembled single substrate.

In order to avoid such uncontrolled breaks 9, while keeping the distances  $d_1$  as small as possible, so that the metal surface 4' provided for on the bottom of the respective single substrate extends as nearly as possible to the edge of this single substrate, as generally required for various reasons, the metal surfaces 4' on the bottom side are provided with a reduction along their edges (edge reduction), generally designated by 10 in Figure 3.

This edge reduction 10 can, as described in more detail below, be achieved in a variety of ways, but is in any case formed in such a way that in the area of this edge reduction 10 the metal volume or the metal mass per volume unit is reduced. The width of the edge reduction is designated by  $a$  in Figure 4 and is, for example, on the order of 0.2 to 6 mm. The reduction of the metal mass or the metal volume is such that the metal mass on the edge reduction 10 is only about 10 to 80% of the metal mass of a metal surface 4' without edge reduction, with reference to a specific volume unit. The edge reduction 10 is also provided for on the metal surfaces 4'' and 4''', along the edges adjacent

to the predetermined break lines 7 and 8, i.e. along the planes SE.

It has been shown that it is possible by means of this edge reduction 10 to provide the metal surfaces 4' with the small distance d1 from the planes SE while still strongly reducing uncontrolled breaks 9, so that altogether a reduction of refuse of up to 75% is possible as compared with conventional methods. Edge reductions on the metal surfaces 3', 3'' and 3''' corresponding to the edge reductions 10 are then necessary or at least desirable, if the distances d2 are smaller than 1mm.

Figures 6 - 15 show examples of various possibilities for forming the edge reduction 10. Figure 5 depicts an edge reduction 10a that is formed by beveling of the edges of the metal surfaces 4', 4'', 4''' adjacent to the planes SE, whereby the diagonal edge surface 11 formed here is in an angle  $\alpha$  that is smaller than  $45^\circ$ .

Figures 6 and 7 show an edge reduction 10b wherein rows of hole-like depressions 12 are formed along the edges of the metal surfaces 4', 4'', 4''' adjacent to the planes SE, whereby these depressions 12 extend to the bottom side of the ceramic layer 2 and have a diameter, for example, of approximately 0.4 to 0.5 mm. The depressions 12 form a simple row of holes in this embodiment. In a possible embodiment, the depressions 12 have a diameter of approximately 0.5 mm. The width a of the edge reduction 10b, within which (width) also the depressions 12 are located, is, for example 0.8 mm, with a distance d1 of approximately 0.5 mm. The width a is hereby defined such that a is the maximum distance that the edges of the depressions 12 have from the adjacent edge of the metalization.

Figure 8 shows a possible embodiment in which the edge reduction 10c is formed by the outer depressions 12, i.e. directly adjacent to the edges of the respective metalization 4', 4'', 4''' and additional inner depressions 13. The latter are offset in relation to the depressions 12 and form, in addition to the outer row of holes (depressions 12) an inner row of holes

(depressions 13), whereby both the depressions 12 and the depressions 13 extend to the bottom side of the ceramic layer 2. The diameter of the depressions 13 in this embodiment is smaller than the diameter of the depressions 12. For example, the width a of the edge reduction 10c, within which (width a) all depressions 12 and 13 are located, is approximately 1.4 mm, whereby the diameter of the outer depressions is approximately 0.6 mm and that of the inner depressions approximately 0.4 mm. The width a is hereby defined such that a is the maximum distance that edges of the depressions 13 have from the adjacent edge of the metalization.

Figure 9 shows as a further possibility for an edge reduction 10d wherein the edges of the metal surfaces 4', 4'' and 4''' adjacent to the planes SE are provided with depressions 14 that are open toward these edges, resulting in meandering edges. The depressions 14 extend likewise to the bottom side of the ceramic layer 2.

In general, with respect to the edge reductions 10b - 10d it is also possible to design all or only some of the depressions 12, 13 or 14 such that they do not extend to the bottom side of the ceramic layer 2, but rather a remainder of the metalization 4 forms the bottom of the respective depression.

Figures 10 and 11 show as a further possibility an edge reduction 10e that is formed by a graduation 15 of the edges of the metal surfaces 4', 4'', 4''' adjacent to the planes SE, i.e. within the width a of the edge reduction 10e the thickness of the material of the respective metal surface increases in steps, for example in the embodiment of Figures 9 and 10 in one step. In general, several steps 15 can also be provided for.

Figures 11 and 12 show as a further possible embodiment an edge reduction 10f wherein the metal surfaces 4', 4'' and 4''' are each provided with a groove-like depression 16 that extends along the edges of the metal surfaces extending along the planes SE and adjacent to these planes, whereby the depression 16 on the metal surfaces 4' is designed as a self-contained groove.

In order to demonstrate that, for smaller distances  $d_2$ , it is at least desirable to provide also the metal surfaces  $3'$ ,  $3''$  and  $3'''$  on the top side of the composite substrate 1 with a corresponding edge reduction, edge reductions 10e and 10f are depicted also for the metal surfaces  $3'$ ,  $3''$  and  $3'''$  in Figures 10 - 13.

Of course, the individual edge reductions 10a - 10f can also be combined, for example on one side of the composite substrate 1, respectively, or on several sides. Furthermore, edge reductions 10 are provided for only where corresponding metal surfaces  $3'$ ,  $3''$ ,  $3'''$  or  $4'$ ,  $4''$ ,  $4'''$  are provided for.

Figures 14 and 15 show as a further possible embodiment similar to Figures 1 and 3 a composite substrate 1a that differs essentially from the composite substrate 1 only in that the metal surfaces  $4''$  and  $4'''$  provided for on the edges 5 and 6 are not present, but only the metal surfaces  $3''$  and  $3'''$  on the top side of the composite substrate.

Figure 16 shows a composite substrate 1b that corresponds, for example, to the composite substrate 1 or 1a, but in which the metal surfaces  $3'$  provided for on the top side for the formation of conductors, contact surfaces etc. are textured for the single substrates as schematically depicted in this figure by the numbers 17, 18 and 19. On the textured surface areas 18, components in the form of semiconductor chips 20 are attached that are electrically connected by means of wire bonds to the corresponding textured areas 17 and 18 forming the electric contact surfaces or connections. Although only depicted for a single substrate or one metal surface  $3'$ , all metal surfaces  $3'$  are textured in this manner and assembled with components, so that a large card or a composite printed board or an assembled composite substrate is produced that is not separated into single substrates or into the individual components or switching circuits until after assembly.

In the above sample embodiments an edge reduction 10 was provided for on the metal surfaces  $4'$ ,  $4''$  or  $4'''$  (of

course, only insofar as these metal surfaces exist) and if applicable also on the metal surfaces 3', 3'' and 3''' along all edges adjacent to a plane SE.

Figure 17 shows in a depiction similar to Figure 2 as a further possibility a composite substrate 1c in which edge reductions 10 are provided for only along part of the edges of the metal surfaces 4', 4'' or 4''' and if applicable also only on part of the edges of the metal surfaces 3', 3'' and 3''', again of course only if the respective metal surfaces actually exist.

The embodiment depicted in Figure 17 is based on the knowledge that random breaks 9 tend to occur when, during separation or breaking of the composite substrate into single substrates, the breakage takes place along a predetermined break line 7 or 8 that extends across several single substrates. For example, if the separation of the composite substrate 1c takes place according to the rule or breaking sequence indicated below, then an edge reduction 10 is not necessary on those edges of the metal surfaces 3' that are adjacent to the predetermined break lines 8 extending between these metal surfaces 3' or the planes SE that enclose the predetermined break line 8 extending between the metal surfaces 4'. The same holds true for the metal surfaces 3'', insofar as an edge reduction is necessary or desirable on these.

In Figure 17 the edges of the metal surfaces 4', 4'', 4''' that are provided with an edge reduction 10 are also cross-hatched. The edges that do not have an edge reduction 10 are depicted as a straight line. As can also be seen in Figure 17, the metal surfaces 4' are not provided with the edge reduction 10 on an edge that is adjacent to a group of predetermined break lines extending between these metal surfaces, namely the predetermined break lines 8 extending in the Y-axis, but on all other edge areas.

The opening of the composite substrate 1c and breaking of this substrate into single substrates then takes place in the following sequence:

1. Breaking of the edges possessing the metal surfaces 3'' or 4'';
2. Breaking of the edges possessing the metal surfaces 3''' or 4''';

3. Successive breaking of the rows or strips in this embodiment, each possessing three single substrates, and extending in the X-axis along the predetermined break lines 7, for example beginning from the upper edge of the composite substrate 1c in Figure 17.

4. Breaking of the single strips produced in this way, each with three single substrates, along the very short remaining predetermined break line 8 in the single strips, into single substrates.

Since the breaking of the strips into single substrates in accordance with number 4 above takes place on predetermined break lines 8, the remaining length of which corresponds to the width of a single substrate, random breaks 9 are less likely here, so that an edge reduction 10 is not necessary along the predetermined break lines 8 extending between the metal surfaces 3' or 4'.

In general, it is also possible to change the breaking sequence, i.e. after breaking off the outer edges possessing the metal surfaces 3'' or 4'' and 4''' or 4''' to first produce strips of single substrates by breaking along the predetermined break lines 8 and then to break these along the predetermined break lines 7. With this breaking sequence edge reductions 10 are in any case also necessary along the predetermined break lines 8 extending between the single substrates, while edge reductions along the predetermined break lines 7 extending between the single substrates are not necessary.

It is, however, generally true that the breaking should always take place on predetermined break lines that are as short



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The invention was described above using sample embodiments. Of course, numerous alternations and adaptations are possible without abandoning the underlying inventive idea of the invention.

## List of reference symbols

	1, 1a, 1b, 1c	composite substrate
	2	ceramic layer
	3, 4	Metalization
5	3', 3'', 3'''	metal surface
	4', 4'', 4'''	metal surface
	5, 6	Edge
	7, 8	predetermined break line
	9	random break line
10	10, 10a, 10b, 10c,	edge reduction
	10d, 10e, 10f	
	11	beveling or diagonal edge surface
	12, 13, 14	Depression
	15	Graduation
15	16	Depression
	17, 18, 19	textured metal surface
	20	Component

003030" 64153450

[illegible]



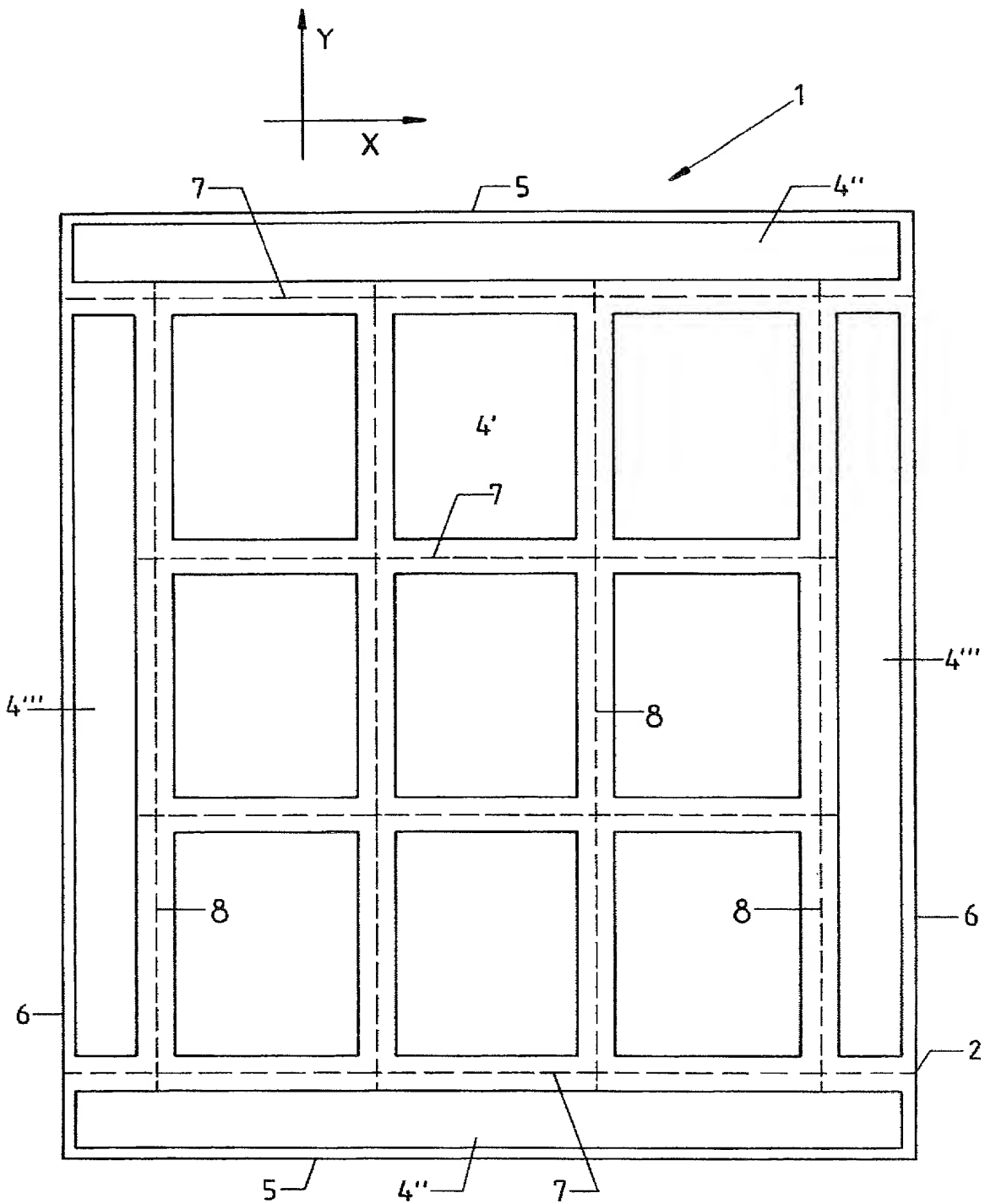
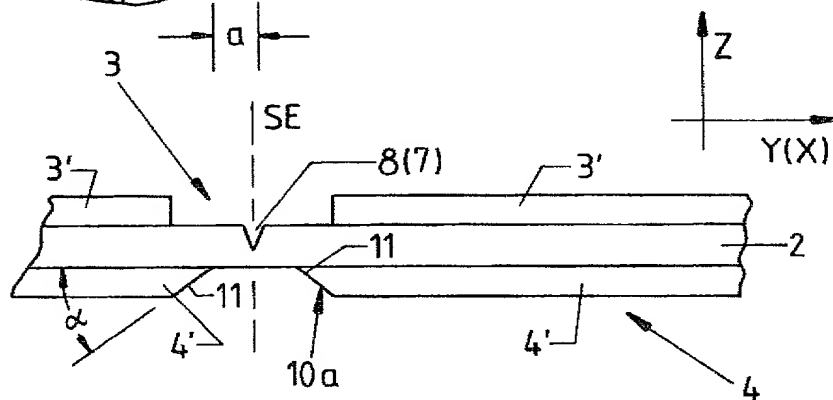


FIG. 2



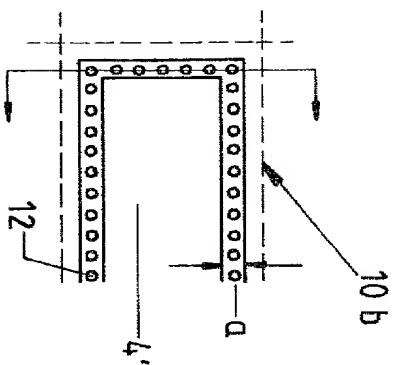


FIG. 6

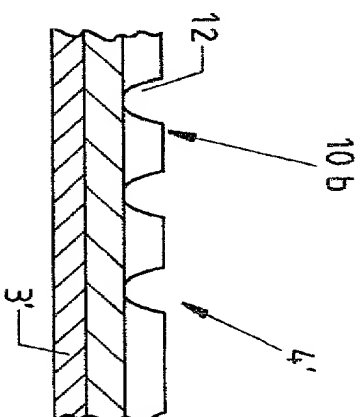


FIG. 7

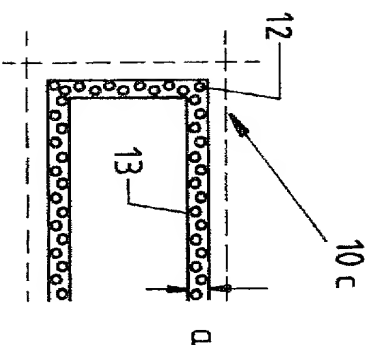


FIG. 8

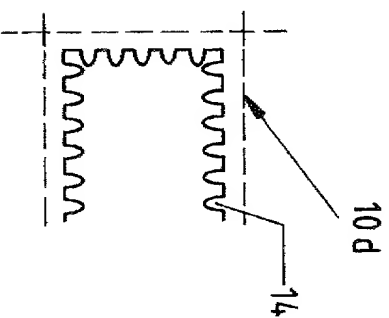
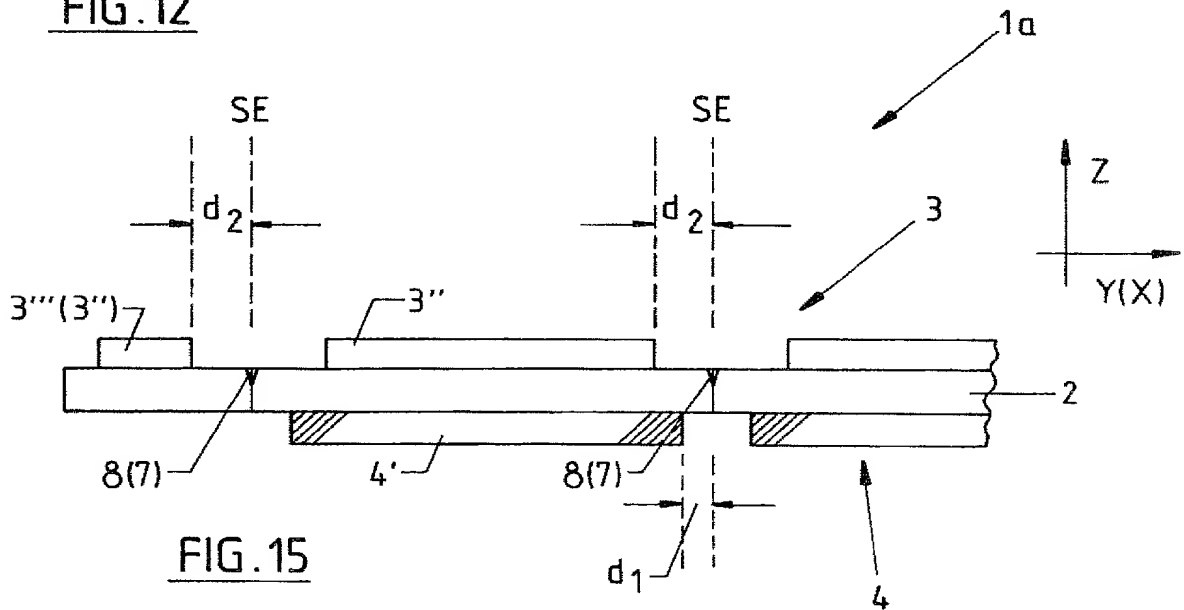


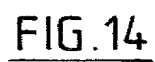
FIG. 9

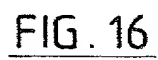
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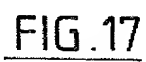
FIG. 15







[illegible]



# Declaration and Power of Attorney for Patent Application

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Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

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My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Ceramic/Metal Substrate, Especially Composite Substrate

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

the specification of which is attached hereto unless the following box is checked:

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☐ was filed on \_\_\_\_\_ as United States Application Number or PCT International Application \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

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Prior Foreign Applications  
(Frühere ausländische Anmeldungen)

Priority Not Claimed  
Priorität nicht beansprucht

199 27 046.5                      Germany  
(Number)                      (Country)  
(Nummer)                      (Land)

14 June 1999  
(Day/Month/Year Filed)  
(Tag/Monat/Jahr der Anmeldung)



(Number)                      (Country)  
(Nummer)                      (Land)

(Day/Month/Year Filed)  
(Tag/Monat/Jahr der Anmeldung)



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(Aktenzeichen)                      (Anmeldetag)

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(Application No.)                      (Filing Date)  
(Aktenzeichen)                      (Anmeldetag)

(Status) (patented, pending, abandoned)  
(Status) (patentiert, schwebend, aufgegeben)

(Application No.)                      (Filing Date)  
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(Status) (patented, pending, abandoned)  
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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*

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Same as above	
Vor- und Zuname des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any
Unterschrift des zweiten Erfinders	Second Inventor's signature
Datum	Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
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(Im Falle dritter und weiterer Miterfinder Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for third and subsequent joint inventors.)